Evaluating Treatment Participation in an Internet-Based Behavioral Intervention for Pediatric Chronic Pain

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Objective Little is known about how participation in internet-based behavioral interventions influences outcomes in youth with health conditions. This study describes participation in an online behavioral pain management intervention for families of adolescents with chronic pain. **Methods** 26 adolescent–parent dyads were randomized to the intervention arm of a controlled trial evaluating a cognitive–behavioral pain intervention. Participation was measured by the number of logins, messages, completion of interactive fields, and behavioral assignments. Associations between content of messages from participants and treatment outcomes were evaluated. **Results** Most participants (92.3%) logged in and completed assignments. Over half of participants initiated messages to the online coach. A greater number of messages sent by adolescents containing rapport or treatment content predicted positive treatment outcomes. **Conclusions** Most families actively participated in the intervention. Interaction with an online coach may increase the benefit of this Internet behavioral pain management treatment program for adolescents.

Key words adolescents; chronic and recurrent pain; computer applications/ehealth; randomized controlled trial.

Introduction

A growing body of literature suggests that Internet interventions are a feasible and potentially efficacious mode of delivering behavioral treatments to youth with chronic illnesses and their families (Stinson, Wilson, Gill, Yamada, & Holt, 2009). Many youth with chronic illnesses do not have adequate access to outpatient psychological services due to a variety of barriers, including difficulty accessing services, lack of trained professionals, and costs (Barlow & Ellard, 2004). Internet interventions are a promising approach for improving access to behavioral health care for these patients.

Internet interventions for delivering behavioral treatments have been developed for a variety of pediatric conditions, including encopresis (Ritterband et al., 2003), traumatic brain injury (Wade et al., 2010), recurrent headache (Trautmann & Kroner-Herwig, 2010), juvenile idiopathic arthritis (Stinson et al., 2010b), diabetes (Mulvaney, Rothman, Wallston, Lybarger, & Dietrich, 2010), asthma (Krishna, Francisco, Balas, Konig, Graff, & Madsen, 2003), and chronic pain (Palermo, Wilson, Peters, Lewandowski, & Somhegyi, 2009). While these studies generally support the feasibility and efficacy of Internet-based behavioral interventions for youth with chronic illness (Stinson, et al., 2009), little is known about how children and families use Internet interventions to reduce symptoms or achieve behavioral changes. Most Internet treatment programs have multiple interactive components, and may be personalized and tailored to address the treatment needs of individual users. Only a few studies have reported on children's use of any component of an Internet program. For example, Ritterband et al. (2006)

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evaluated the added value of audio, graphics, and interactivity in an Internet intervention for pediatric encopresis showing that use of an interactive program, compared to a static web program without these features, was associated with increased child and parent understanding of treatment content, motivation, and readiness to change.

External support such as an online coach is one specific component of Internet programs that has been used in behavioral interventions for youth with chronic illness (Palermo et al., 2009; Trautmann & Kroner-Herwig, 2010; Wade et al., 2010) with unclear benefit. External support has ranged from the use of real-time communication via videoconferencing (Wade et al., 2010) to asynchronous communication via online messaging systems (Palermo et al., 2009; Trautmann & Kroner-Herwig, 2010). Other programs are fully computer automated and do not include any external support (Ritterband et al., 2003). When utilized, the role of an online coach has been to provide personalization, tailoring, and feedback on skills practice (Palermo et al., 2009; Wade, et al., 2010). Given the costs in terms of time, energy, and financial resources associated with the use of external support in Internet interventions as opposed to fully computer automated programs, research describing how participants interact with an online coach and whether this impacts treatment outcome in children with chronic health conditions may help to advance understanding of treatment process in Internet interventions.

A recent review of Internet-based health promotion behavioral interventions for adult populations specifically examined the contribution of external support to treatment outcomes (Fry & Neff, 2009). Findings indicated enhanced effectiveness for Internet programs that incorporated tailored messages from an online coach compared to programs that used fully computer automated messaging systems, as well as programs that did not send messages to participants. To our knowledge, however, studies have not yet examined how participants use external support and communicate with an online coach in Internet interventions. Similar to the therapy process in face-to-face cognitive–behavioral interventions for children and adolescents, the frequency, nature, and type of communication between an online coach and program users may influence treatment participation and impact treatment outcomes. Therefore, the primary aim of this study was to describe participation in an online cognitive–behavioral therapy (CBT) program for adolescents with chronic pain and their parents. We have previously described the development and initial feasibility testing of our Internet-based behavioral pain management program (Long & Palermo, 2009) as well as primary treatment outcomes in adolescents participating in a randomized controlled trial (Palermo et al., 2009). The unique focus of this report is on examining participation in the Internet program by families assigned to the Internet intervention arm of the randomized controlled trial (Palermo et al., 2009).

We hypothesized that we would be able to measure treatment participation based on use of four components of the web program. We expected that adolescents and their parents would participate in the Internet intervention by logging in to the web program, completing interactive fields and behavioral assignments, and sending messages to an online coach. The second aim of this study was to further examine the external support component of the Internet program by evaluating whether the content of messages sent by adolescents and parents to the online coach was associated with treatment outcomes of pain and activity limitations. We hypothesized that message content focused on rapport and treatment, but not study and technical issues, would be related to reductions in adolescent pain intensity and activity limitations from pre- to posttreatment.

Methods

Participants

Participants included 26 adolescents (20 girls, 6 boys) between the ages of 11 and 17 years ($M = 14.31$, $SD = 2.08$) with chronic pain who were randomized to the Active Intervention arm of a controlled trial that examined the efficacy of an Internet-based behavioral pain management intervention. Participants were referred by pediatric specialty care physicians in multidisciplinary pediatric pain, neurology, and gastroenterology clinics at an academic medical center. Detailed procedures and sample description are reported in Palermo et al. (2009).

In the randomized controlled trial, participants in the intervention group showed significantly greater reduction in pain and activity limitations from pre- to posttreatment than participants in a wait-list control group (Palermo et al., 2009). The unique focus of this report is on describing treatment participation in the Internet program, including examining associations between the external support component and treatment outcome. All procedures were approved by the Institutional Review Board of the medical center where the study was conducted and written informed consent and assent were obtained from parents and children. Participants were compensated with gift cards to local stores upon completion of pre- and posttreatment assessments. Compensation was not contingent upon usage or participation in the Internet program.

Internet Program

As described in Palermo et al. (2009), the online CBT program was designed for adolescents with chronic pain and their parents. The program is travel-themed and has separate versions for adolescents and parents. The program has over 200 page views and includes instructional handouts, interactive animations, short quizzes, audio clips of relaxation exercises, and video clips of peer models. This brief intervention is designed to take 8–10 weeks to complete. Participants visit eight different modules, each of which focuses on different cognitive and behavioral skills related to pain management, such as recognizing stress, relaxation strategies, and cognitive skills. Parents and children are asked to log in and read one treatment module per week. Each module takes approximately 30 min to complete. Participants who did not log into the program for 2 weeks were contacted by phone or email with a reminder to log on to the program.

Interactive fields were present in all of the modules, which allowed for personalized instructions. For example, in the module focused on parent operant training, parents are asked to input the behaviors they want to target in a behavior management plan. These behaviors are then re-populated later in the module to remind parents about the behaviors that they want to focus on in the behavior plan they carry out the next week. Completion of interactive fields is not required to move forward in the modules and a failure to complete these fields results in generic versus personalized instructions (e.g., general behavior plan versus specific, individualized plan).

In six of the eight adolescent treatment modules (Modules 2–7) and seven of the eight parent treatment modules (Modules 1–7), participants are instructed to complete a behavioral assignment focused on practicing the skills learned in that week's module. For example, in the module focused on relaxation training, adolescents are asked to practice relaxation skills each day for the next week. Participants are asked to log in at the end of the week to complete the assignment by answering a series of forced-choice and open-ended questions about their skills practice. Assignment questions are designed to elicit information regarding perceived helpfulness of behavioral skills, use, and whether there were any barriers to implementing skills. Each time participants complete an assignment they receive a personalized message from an online coach, which is described in more detail below. The online coach is required to approve each assignment in sequence for participants to access the next assignment (e.g., complete assignment one before assignment two), thereby ensuring that assignments are completed in order and to encourage continued participation in the program.

Specific content for the Internet intervention was derived from CBT and social learning theory. The topics of the eight adolescent modules included: (1) education about chronic pain, (2) recognizing stress and negative emotions, (3) deep breathing and relaxation, (4) distraction, (5) cognitive skills, (6) lifestyle factors, (7) increasing physical activity, and (8) maintenance and relapse prevention. The eight parent modules included: (1) education about chronic pain, (2) recognizing stress and negative emotions, (3) operant strategies I, (4) operant strategies II, (5) modeling, (6) lifestyle factors, (7) communication skills, and (8) maintenance and relapse prevention. More detailed information on the content of the Internet intervention can be found in Palermo et al. (2009). Participants could access content from all of the modules at anytime (e.g., read any module), but were required to complete assignments in a specific sequence.

Online Coach

A PhD level psychology postdoctoral fellow with specialized training in behavioral pain management served as the online coach. Participants communicated with the online coach via a message center on the home page of the website. The content of all messages sent by the online coach to participants were based on a manual developed for this study so that the content of messages sent by the online coach was similar across all participants. The primary role of the online coach was to increase personalization and tailoring through responding to behavioral assignments submitted by adolescents and parents. Upon receipt of each behavioral assignment, the online coach sent a manualized, personalized message that summarized progress in the program, encouraged continued skills practice, and assisted in problem-solving around any treatment barriers reported by participants in their assignment response. In addition, participants were able to initiate messages to the online coach through the message center at any time to discuss treatment information, to talk about any difficulties carrying out behavioral skills, or if they needed technical assistance. Participants were required to submit assignments to move through the web program, but otherwise were not required to send messages to the online coach. Responses by the online coach to participant-initiated messages were also manualized and focused on encouraging continued skills practice, assisting in problem-solving around treatment barriers, and addressing any technical issues. External support in this Internet program referred to a two-way exchange of communication between the online coach and the participant. Due to the

lack of variance in the content of messages sent by the online coach, participant-initiated messages are the focus of our analysis of the external support component of the Internet intervention.

Procedures

Adolescents continued with the standard medical care recommended by their specialty care physician. As described in Palermo et al. (2009), primary study outcomes were pain intensity and activity limitations at pre- and posttreatment. Pretreatment assessment was conducted prior to randomization, and posttreatment assessment was conducted after program completion, about 10 weeks later.

Measures

Treatment Participation

Treatment participation was assessed using logins, interactive fields, assignments, and messages.

Logins. Logins refers to the total number of times that participants logged in to the Internet program using their unique password.

Interactive fields. The total number of interactive fields completed by participants and the total word count for all interactive fields were recorded. Adolescents could complete up to 38 interactive fields, and parents could complete up to 51 interactive fields.

Behavioral assignments. The total number of behavioral assignments completed by participants and the total word count in those assignments were recorded. Adolescents could complete six assignments, and parents could complete seven assignments.

Messages. The total number of messages sent by participants to the online coach and the total word count in those messages were recorded.

In order to examine the content of the messages that participants sent to the online coach, a narrative coding scheme was developed. This coding scheme was categorical and nonexclusive, and specified three types of message content: rapport, treatment, and study or technical issues. Use of a nonexclusive coding scheme allowed a single message to receive more than one code as necessary. Two members of the research team independently coded 20% of the messages to establish reliability. Inter-rater reliability was high, $\kappa = .97$.

The category rapport included messages using expressions of personal communication and efforts to relate to the online coach, such as: (1) sharing personal information not related to pain problems or treatment, (2) asking personal questions about the online coach, (3) use of emoticons or SMS language (e.g., ''lol''), and (4) expressions of gratitude. Writing the word thanks/thank you at the end of a message and messages that only consisted of the word thanks/thank you were excluded. The following is an example of a message coded as rapport content:

> Hey, thanks so much for the words of wisdom and advice. I didn't know it was gonna be you readin the assinments, part of me thought it was gonna be a computer. Thats pretty tight. Aight, well ima make this email short cuz I'm sure you have a bunch to read, so layta (sic; a 17-year-old boy).

The category treatment included messages directly related to the skills being taught in the Internet program or about the adolescent's progress with his or her treatment goals, including: (1) use of skills taught in the program, (2) descriptions of the adolescent's pain problem, and (3) information pertaining to the adolescent's progress with treatment goals (e.g., current ability to participate in activities). The following is an example of a message coded with treatment content:

> She got a migraine today at summer school going to the mall with her class which she knew could be a trigger, and she had strategies prepared, and is not coddling herself, and so in this small sample shows a big improvement. And I told her she's got to try to do homework tonight too (sic; parent of a 15-year-old girl).

The category study or technical issues represented questions from participants about study coordination and technical issues related to the website, including: (1) mailing reimbursement, (2) questions about how to complete measures, (3) reports of delays in progressing through the program, (4) reports of technical problems, (5) inquiries about whether online assignments were received, and (6) feedback about the website. The following is an example of a message in this category:

> I've been experiencing computer problems and had to replace the hard drive of the computer that I use to access the program, so I must apologize if I am falling behind in my usage (sic; a 16-year-old boy).

Treatment Outcomes

As part of the randomized controlled trial (Palermo et al., 2009), pre- and posttreatment usual pain intensity was assessed using an 11-point numerical rating scale (NRS)

ranging from 0 (no pain) to 10 (worst possible pain). The NRS has demonstrated good reliability and validity in children and adolescents (von Baeyer et al., 2009). Pre- and posttreatment activity limitations were assessed using the Child Activity Limitations Interview (CALI), which assesses difficulty in performing daily physical, social, and recreational activities due to pain. Total scores range from 0 to 32. The CALI has demonstrated excellent internal consistency as well as good test-retest reliability and validity (Palermo, Witherspoon, Valenzuela, & Drotar, 2004).

Data Analytic Plan

Statistical analyses were performed using the Statistical Package for the Social Sciences, Version 18.0. Descriptive statistics were calculated for the number of logins, number of completed interactive fields, number of messages sent to the online coach, and word counts for interactive fields and messages. In addition, means and ranges were examined for each category of message content (i.e., rapport, treatment, and study and technical issues). Multivariate analysis of variance (MANOVA) was used to evaluate differences in program usage and message content between adolescents and parents. Residualized change scores were calculated to determine change in pain intensity and activity limitations scores from pre- to posttreatment. Pain intensity residualized change scores were calculated by regressing posttreatment pain intensity scores on pre-treatment pain intensity scores. Activity limitations residualized change scores were calculated by regressing posttreatment CALI scores on pre-treatment CALI scores. In order to evaluate associations between external support and youth treatment outcomes, separate hierarchical linear regressions were conducted to evaluate each message category (rapport, treatment, and study and technical issue) by each participant (adolescent, parent) as predictors of pain intensity and activity limitations change scores. Adolescent age, gender, number of website logins, and pre-treatment outcome scores were entered on Step 1, and message content was entered on Step 2. Family-wise Bonferroni correction was used to account for the multiple regression analyses, and statistical significance was set at $p < .01$.

Results

Demographic Characteristics

Sample characteristics are shown in Table I. Participants included 26 adolescents aged 11–17 years ($M = 14.3$, $SD = 2.1$) and a parent randomized to the Internet treatment arm of a randomized controlled trial of the efficacy of online behavioral pain management. Participants were primarily female (76.9%) and Caucasian (88.5%). Parent participants were primarily mothers (81%). Families were predominantly middle class; the majority of the sample reported an average family income of $50,000. Participants were referred to the study for treatment of abdominal pain (53.8%), musculoskeletal pain (30.8%), and head pain (15.4%). The majority of participants reported experiencing pain occurring daily (76.9%) that was moderate to severe in intensity.

Table I. *Sample Characteristics (n = 26)*

Characteristic	*n* (%)/*M* (*SD*)
Child age (years)	14.31 (2.08)
Child gender	
Female	20 (76.9%)
Male	6 (23.1%)
Racial background	
Caucasian	23 (88.5%)
Asian/Pacific Islander	1 (3.8%)
Other/biracial	2 (7.7%)
Primary pain location	
Head	4 (15.4%)
Abdomen	14 (53.8%)
Musculoskeletal	8 (30.8%)
Pain frequency	
1–6 times/week	6 (23.1%)
Daily	20 (76.9%)
Baseline usual pain intensity (NRS)	6.5 (1.9)
Baseline activity limitations (CALI)	5.9 (4.6)

Descriptive Information About Program Usage

The majority of families completed the Internet treatment program in 15 weeks with a range of 7–27 weeks. Twenty adolescents (77%) completed all eight treatment modules and the remaining seven (23%) completed at least two modules (range 2–7). Fourteen parents (54%) completed all eight modules and the remaining 12 (46%) completed at least one module (range 1–7). Descriptive information about program usage is shown in Table II.

On average, adolescents logged into the website 25 times ($SD = 15.5$) and parents logged into the website 14 times ($SD = 9.0$) during the intervention period. All participants logged in to the program at least once during the intervention period. Adolescents completed an average of 75% of the interactive fields ($SD = 25.7\%$) and parents completed an average 57% of the interactive fields ($SD = 27.3\%$). Total word count for the interactive fields was $M = 190.6$ ($SD = 93.5$) for teens and $M = 238.2$ ($SD = 133.2$) for parents. Adolescents completed an average of 89% ($SD = 24.9\%$) of the assignments; 21 adolescents (81%) completed all six assignments. Parents

Table II. *Descriptive Statistics for Adolescent and Parent Internet Treatment Participation*

	Adolescent		Parent				
Measure	*M* (*SD*)	Range	*M* (*SD*)	Range	*F*	*p*	η^2
Message category					1.55	.21	.09
Rapport	0.42 (.86)	0–4	0.42 (1.10)	0–5		1.00	.00
Treatment	0.35 (.89)	0–4	0.54 (1.10)	0–4		.49	.01
Study and technical issues	0.77 (1.31)	0–6	1.62 (2.28)	0–9		.11	.05
Program usage					4.71	<.01	.23
Number of logins	24.50 (15.52)	2–65	13.65 (9.02)	1–35		<.01	.16
Messages							
Number sent	1.23 (1.70)	0–7	1.88 (2.63)	0–9		.29	.02
Total number of words	32.58 (42.92)	0–159	70.00 (92.18)	0–295		.07	.07
Interactive fields							
% Completed	75.51 (25.66)	0–100	56.94 (27.31)	0–100			
Total number of words	190.62 (93.46)	0–407	238.23 (133.17)	0–578			
Assignments							
% Completed	89.10 (24.92)	33–100	84.07 (26.90)	14–100			
Total number of words	113.65 (69.41)	0–266	261.46 (197.86)	0–829			

completed an average of 84% ($SD = 26.9\%$) of the assignments; 16 parents (62%) completed all seven assignments. All participants completed one or more assignments. Since assignments included forced-choice and open-ended questions, it was possible to complete assignments without entering any words. Total word count for the assignments was $M = 113.7$ ($SD = 69.4$) for teens and $M = 261.5$ ($SD = 197.9$) for parents.

Since participants were required to complete assignments in a specified sequence, earlier modules and assignments were more likely to be completed than later modules and assignments. One adolescent and two parents completed more assignments than treatment modules. In all three cases, participants completed Modules 1–7 and all corresponding assignments but did not go on to read the final module (which did not include an assignment). Given our small sample size, this resulted in a slightly higher rate of individuals who completed all assignments ($n = 21$ teens, 81%; $n = 16$ parents, 62%) relative to individuals who completed all modules ($n = 20$ teens, 77%, $n = 14$ parents, 54%). The vast majority of participants (92.3%) logged in to the web program, used interactive fields, and completed assignments. There were only two teens and two parents who logged into the program but did not complete any interactive fields or type any words into the assignments.

Adolescents sent a total of 30 messages to the online coach, for an average of one to two messages per adolescent ($SD = 1.7$). Parents sent a total of 32 messages to the online coach, for an average of one to two messages per parent ($SD = 2.6$). In total, 14 adolescents (53.9%) and 16 parents (61.5%) initiated messages to the online coach. Higher baseline pain intensity was associated with more frequent use of the message center by adolescents ($r = .38$, $p = .05$). In exploratory correlational analyses, use of the message center by adolescents and parents was not found to be related to any other demographic or clinical factors.

For adolescents and parents, self-initiated messages to the online coach were distributed across all three coded categories with slightly higher rates of messages regarding study and technical issues.

Differences Between Adolescents and Parents in Program Usage

MANOVA revealed significant differences in logins and messages sent to the online coach between adolescents and their parents, $F(3,48) = 4.71$, $p = .002$; this was a medium effect size, partial $\eta^2 = .23$. Teens logged in significantly more times than parents, $p < .01$ (see Table II). There were no significant differences in number of messages sent or number of words in messages. Adolescents and parents sent a similar number of messages to the online coach coded as rapport, treatment, or study and technical issues, $F(3,48) = 1.55$, $p = .21$.

Relationship Between External Support and Youth Treatment Outcomes

Separate hierarchical linear regressions evaluated associations between online messages (external support) and pain intensity residualized change scores after controlling for age, gender, number of logins, and baseline pain intensity scores. Statistical significance was set at $p < .01$ to correct for multiple analyses. Consistent with hypotheses, the

Table III. *Multiple Linear Regressions Predicting Reductions in Pain Intensity at Posttreatment*

Variable	Beta (95% CI)	SE	Std Beta	*t*	*p*	Total R^2	ΔR^2	f^2
Adolescent rapport content as predictor						.96	.01*	
Step 1								
Age	0.00 (−0.04, 0.04)	0.02	0.00	−0.04	.97			<.001
Gender	−0.17 (−0.40, 0.05)	0.11	−0.08	1.54	.14			.005
Logins	0.01 (0.009, .01)	0.00	0.08	1.59	.13			.005
Baseline pain intensity	0.50 (0.44, 0.56)	0.03	0.93	17.44	<.001			1.57
Step 2								
Messages with rapport content	0.15 (0.01, 0.30)	0.07	0.13	2.25	.04			.01
Adolescent treatment content as predictor						.98	.02**	
Step 1								
Age	0.00 (−0.04, 0.04)	0.02	0.00	−0.03	.98			<.001
Gender	0.07 (−0.14, 0.27)	0.10	−0.03	−0.71	.49			<.001
Logins	0.00 (−0.01, 0.01)	0.00	0.05	1.04	.31			.002
Baseline pain intensity	0.50 (0.44, 0.56)	0.03	0.91	19.93	<.001			1.58
Step 2								
Messages with treatment content	0.20 (0.07, 0.32)	0.06	0.19	3.56	.002			.02
Adolescent study/ technical issues as predictor						.97	.002	
Step 1								
Age	−0.15 (−0.19, 0.10)	0.02	−0.03	−0.63	.54			.001
Gender	−0.27 (−0.50, −0.04)	0.11	−0.11	−2.41	.03			.01
Logins	0.01 (0.009, 0.01)	0.00	0.12	2.36	.03			.01
Baseline pain intensity	0.53 (0.47, 0.59)	0.03	0.98	19.03	<.001			6.51
Step 2								
Messages with study/technical issues	0.04 (−0.04, 0.12)	0.04	0.05	1.01	.32			.002

Note. CI = confidence interval. Effect size conventions for f^2 are as follows: small = .02, medium = .15, large = .35 (Cohen, 1992).
*$p < .05$. **$p < .01$.

treatment category of online messages sent by adolescents was significantly related to pain intensity change scores, $\beta = .20$, $p = .002$, while rate of study and technical issues messages were not related to pain intensity change scores. However, contrary to hypotheses, there was no relationship between the rapport category of online messages from adolescents and pain intensity change scores, $\beta = .15$, $p = .04$ (see Table III). There was also no relationship between any category of online messages from parents and adolescent pain intensity change scores, β's = .03–.07, p's > .01.

Similarly, separate hierarchical linear regressions evaluated the relationship between online messages and the outcome activity limitations using residualized change scores after controlling for age, gender, number of logins, and baseline activity limitations scores. Consistent with hypotheses, rate of adolescent initiated messages with rapport and treatment content were significantly related to activity limitations change scores, $\beta = .18$, $p = .005$ and $\beta = .17$, $p = .006$, respectively, while number of study and technical issues messages were not related to activity limitations change scores (see Table IV). Contrary to hypotheses and consistent with the above finding concerning pain intensity, there was no relationship between the content of parent initiated messages and adolescent activity limitations change scores, β's = .02–.07, p's > .24.

Discussion

The present study described preliminary findings concerning participation in an Internet behavioral intervention for adolescents with chronic pain and their parents. Families demonstrated a high level of participation in the web program, as indicated by the number of web logins, messages and completed assignments, and amount of text entered. These findings add to the limited available data on how children and parents use Internet-based behavioral interventions to reduce symptoms and make behavioral changes (Ritterband, et al., 2003). While other researchers have examined feasibility and usability of Internet interventions in beta or pilot testing phases (Long & Palermo, 2009; Stinson et al., 2010a), there has been inadequate attention focused on the actual use of intervention content and web program features during intervention implementation. Although there has been an explosion of interest in creating

Table IV. *Multiple Linear Regressions Predicting Reductions in Activity Limitations at Posttreatment*

Variable	Beta (95% CI)	SE	Std Beta	*t*	*p*	Total R^2	ΔR^2	f^2
Adolescent rapport content as predictor						.96	.02**	
Step 1								
Age	0.01 (−0.03, 0.05)	0.02	0.01	0.26	.80			<.001
Gender	0.16 (−0.05, 0.037)	0.10	0.08	1.58	.13			.005
Logins	0.00 (−0.01, 0.01)	0.00	0.05	1.00	.33			.002
Baseline activity limitations	0.16 (0.14, 0.18)	0.01	0.96	19.68	<.001			3.50
Step 2								
Messages with rapport content	0.18 (0.05, 0.30)	0.06	0.16	3.13	.005			.02
Adolescent treatment content as predictor						.98	02**	
Step 1								
Age	0.00 (−0.04, 0.04)	0.02	0.00	−0.06	.96			<.001
Gender	0.22 (−0.01, 0.44)	0.11	0.10	1.96	.06			.008
Logins	0.00 (−0.01, 0.01)	0.00	0.04	0.75	0.46			<.001
Baseline activity limitations	0.16 (0.14, 0.18)	0.01	0.98	20.50	<.001			5.84
Step 2								
Messages with treatment content	0.17 (0.04, 0.30)	0.06	0.16	3.07	.006			.02
Adolescent study/technical issues as predictor						.98	.005	
Step 1								
Age	−0.01 (−0.05, 0.03)	0.02	−0.02	−0.44	.66			.005
Gender	0.05 (−0.20, 0.30)	0.12	0.02	0.41	.69			.004
Logins	0.01 (0.009, 0.01)	0.00	0.10	1.77	.09			.009
Baseline activity limitations	0.16 (0.14, 0.18)	0.01	0.98	17.54	<.001			5.28
Step 2								
Messages with study/technical issues	0.06 (−0.02, 0.14)	0.04	0.08	1.37	.19			.005

Note. Effect size conventions for f^2 are as follows: small = .02, medium = .15, large = .35 (Cohen, 1992).
**$p < .01$.

Internet interventions for a variety of pediatric health and mental health conditions, there is a relative dearth of information to guide researchers and web developers about the importance of specific web program features such as messaging, interactive text fields, and external support. Data such as these from clinical trials of Internet interventions with youth and parents may help to inform the development of future Internet interventions.

This study also extends previous research by documenting a relationship between the types of communications that participants initiate with online coaches and treatment outcomes. Sending messages to the online coach that contained rapport or treatment content was associated with enhanced treatment outcomes for adolescents, above and beyond the number of times that they logged into the web program. These results support Ritterband et al.'s (2009) hypothesis that treatment participation is related to improved treatment outcomes for users of Internet interventions, and suggest that an external support component may play an important role in this process, at least for youth with chronic pain. Our findings are also consistent with studies of health promotion Internet interventions for adult populations in which interaction with an online coach enhanced treatment effectiveness (e.g., Tate, Jackvony, & Wing, 2006). Baseline pain intensity and activity limitations were also strong predictors of posttreatment reductions in pain and activity limitations, respectively, which suggests that greater pre- to posttreatment changes were achieved by adolescents with worse initial pain and functional disability perhaps due to enhanced motivation to participate in the treatment program.

A variety of factors may have predisposed adolescents to engage with the online coach. Our results suggest that adolescents with greater pain intensity were more likely to interact with the online coach, whereas other demographic factors such as age, gender, and socioeconomic status were not, at least in our exploratory analyses, related to sending messages to the online coach. It is also possible that adolescents who began the online program with a high readiness to change were more likely to engage with the online coach and send messages that discussed their experience using skills taught in the program, or to disclose personal information. Research is needed to determine the interrelationship between motivation/readiness to change and participation with Internet interventions, and to identify

whether there are any web program features that could enhance motivation and improve participation. Moreover, individual factors require further study in larger samples concerning Internet treatment participation.

Notably, results from this study indicated that the types of communications that parents sent to the online coach were not related to changes in their adolescents' pain intensity or activity limitations. It is possible that external support in Internet interventions may be more beneficial for adolescents than for parents in terms of enhancing intervention effectiveness or that we did not as successfully engage parents in our web program. However, it is unclear whether this result is due to the small sample size of the current study or the use of child-reported treatment outcomes. Parents also sent more messages to the online coach regarding study logistics and technical issues, although this difference was not statistically significant. It is not possible to determine whether parents actually experienced more technical problems than adolescents, or if they were simply more likely to report technical issues to the online coach on behalf of their family. Further research is needed to better understand associations between parental use of external support and effectiveness of Internet interventions. Future research could also examine differences in quantity and patterns of treatment participation between parents and adolescents.

Research is also needed to evaluate the best indicators of treatment participation in Internet interventions. In the current study, we selected measures of treatment participation that have been theorized to be related to behavior change in users of Internet interventions (Ritterband et al., 2009). Additional features that we did not examine, such as time spent on specific elements of the web program or temporal patterns of web program use, could also be used to describe treatment participation in Internet interventions. However, careful consideration must be given to what is actually being measured by assessments of Internet intervention program usage. For example, there are inherent difficulties with time usage metrics such as a simple count of minutes spent logged in to the web program. It is not possible to determine from such metrics how much of that time participants actually spent viewing the web program compared to time spent doing other activities, such as viewing other websites, or forgetting to log out of the web browser before leaving the computer. Further research is needed to better understand the generalizability of measures used to evaluate treatment participation in Internet interventions.

Dismantling or deconstruction studies are also needed to identify the individual components of existing Internet interventions that produce the greatest impact on treatment outcomes. Similarly, mantling designs could be used to evaluate active components of Internet interventions that are currently under development and have not yet been evaluated for treatment efficacy (e.g., Danaher & Seeley, 2009). Studies with larger sample sizes are needed to replicate our preliminary findings reported here to determine whether specific features of Internet interventions, such as behavioral assignments and interactive text fields, are related to treatment outcomes. Similarly, further research is needed to determine whether communication with an online coach is a critical component of Internet interventions for children with chronic health conditions and their parents. Although our preliminary results suggest that certain types of communications with an online coach may be associated with enhanced treatment outcomes, the use of an online coach requires careful consideration and further outcome data. Specifically, such data will assist investigators in understanding the cost–benefit ratio of whether the increased costs and more limited wide-scale dissemination (Ritterband et al., 2009) associated with external support is balanced against potentially enhanced treatment outcomes. Studies directly comparing Internet interventions with external support to the same intervention without external support will extend knowledge in this area.

There are several limitations to our data that should be considered when interpreting our findings. First, our results are preliminary given our small sample size. Studies with larger sample sizes are needed to replicate these findings and also to evaluate other components of web programs that were not measured in the present study (e.g., use of video and audio files, content of messages sent by the online coach). It is also unknown whether our preliminary findings in the specific study population of adolescents with chronic pain will generalize to children using Internet interventions who have other medical conditions.

Despite these limitations, this study adds to the limited literature regarding participation in Internet-based behavioral interventions for pediatric populations. Preliminary results indicated that treatment participation could be measured using the number of logins, messages and assignments completed, and amount of text entered in the web program by participants. Findings from this study also suggest that external support through an online coach is used by adolescents and parents and may be related to enhanced treatment outcomes. Internet interventions are a promising mechanism for providing behavioral treatment to youth with chronic health conditions who may have more difficulty accessing and receiving specialized behavioral health services in their own communities. Research regarding how children and parents engage with

and participate in Internet interventions can be used to inform the development of new web programs and enhance treatment effectiveness.

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